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CONVAIR ASTRONAUTICS

CONVAIR DIVISION OF GENERAL DYNAMICS CORPORATION

MECHANICAL PROPERTIES OF ADLOCK 851 AT ROOM TEMPERATURE, 1000°, -320° AND -423°F

REPORT NO. 55E 812

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MECHANICAL PROPERTIES OF ADLOCK 851 AT ROOM TEMPERATURE, 1000°, -320° AND -423°F

OBJECT:

To determine the tensile and flexural properties of Adlock 851 fiberglass laminate at room temperature, 1000°, -320° and -423°F.

CONCLUSIONS:

Flexural Test. The maximum fiber stress for this particular cure of Adlock 851 increased from 65.4 ksi at 78° to 84.3 ksi at -320°F. Fiber stress values then decreased from 84.3 ksi at -320°F to 81.0 ksi at -423°F. Deflection values to failure also follow the same trend, i.e., increasing from 0.121 inches at 1000°F to 0.149 inches at -320°F and then decreasing to 0.117 inches at -423°F. Modulus of elasticity values increase consistently with decreasing temperature from 2.92×10^6 at 78° to 3.49×10^6 at -423°F.

Tensile Properties. The tensile properties of Adlock 851 follow along the same general lines as the flexural test results. The ultimate strength increased from 31.5 ksi at 1000°F to 73.6 ksi at -320°F. From -320°F to -423°F, the ultimate strength decreased from 73.6 ksi to 63.6 ksi.

SPECIMENS:

The tensile specimens were the standard 9 inch coupons machined according to Structural Standard 001 (Figure 1).

Flexural specimens were machined according to Figure 2.

PROCEDURE:

Flexure specimens tested at 1000°F were heated to this temperature on one side only. It took 90 seconds to reach 1000°F from ambient.

A static load of 6 ksi was placed on the flexure specimens prior to heating. Photographs of the test set up are shown in Figures 5 and 6. Heat was applied to the flexure specimens with a series of quartz heat lamps, whose output was controlled by a 115V variable autotransformer. Temperature readings were followed by attaching a thermocouple to the heated side of the specimen and recording millivolt output on a Sanborn 150 Recorder. Deflection values were determined by using a linear transducer in conjunction with a Sanborn 150 Recorder. Maximum deflection values, at failure, were recorded at the highest temperature reached.

Flexural tests at the other temperatures used the same test set up but the environment was changed to room temperature, liquid nitrogen and liquid hydrogen for the other reported temperature.

From the recorded values, maximum fiber stress and modulus of elasticity in bending was calculated. The following formulas were used to calculate maximum fiber stress and the modulus of elasticity in bending respectively:

(1) $$S = \frac{3PL}{2bd^2}$$

Where S = maximum fiber stress psi
P = maximum load in pounds
L = distance between supports, inches
b = width of beam tested, inches
d = depth of beam tested, inches

(2) $$E_B = \frac{L^3}{4bd^3} \quad (P/Y)$$

Where E_B = modulus of elasticity in bending
L = distance between supports, inches
b = width of beam tested, inches
d = depth of beam as tested, inches
P/Y = slope of straight line portion of load deflection curve in pounds/inch

Tensile specimens were tested at 1000°F, ambient, -320°F and -423°F. Stress strain curves were run on each specimen.

RESULTS AND DISCUSSION:

The results of the flexural and tensile data at 1000°F, room temperature, -320°F and -423°F are given in Figures 3 and 4. The values reported for the tensile test are open to question for the following reasons:

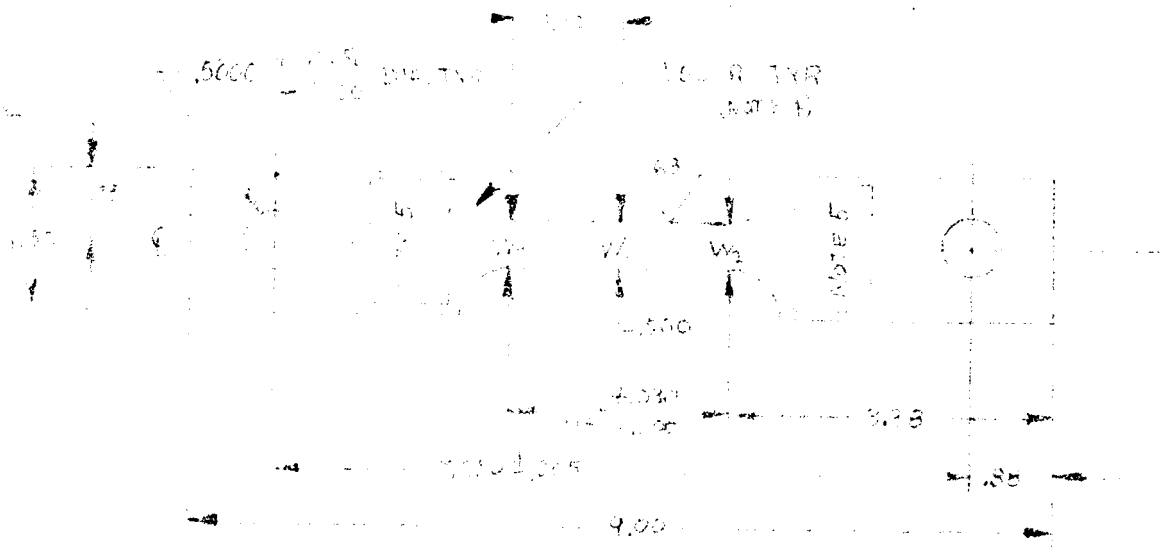
1. Many of the specimens failed in the end fitting at 1000°F.

2. All of the ambient tensile specimens failed in the radius and not in the center of the test area.

3. Failure at cryogenic temperatures was either in the end fitting, in the radius, or was initiated by the knife edges which were used to obtain stress strain data.

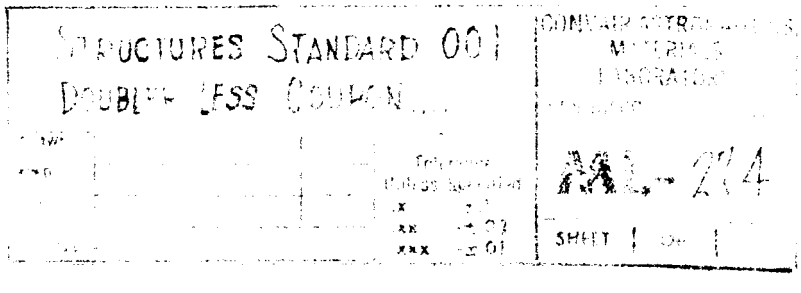
The tensile data is recorded in Figure 4.

PHOTO INDEX



NOTES

1. Holes on centerline of test section within ± .005.
2. Gradual taper from W_2 to W_1 of .004 ± .001 in. W_2 to be greater than W_1.
3. Test section to have sharp corners free from burrs.
4. No undercut at intersection of radius and test section.
5. Identify here by electro etch with Heat No., Coil No., Specification No., and Specimen No.



FLEXURAL SPECIMEN

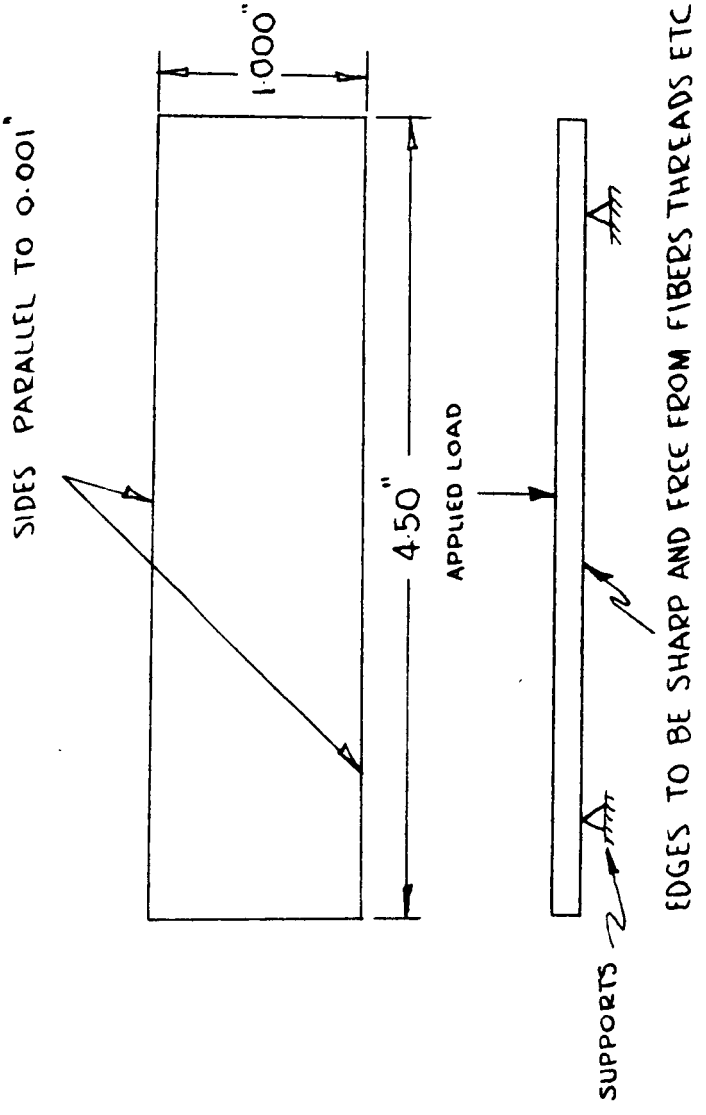


FIG 2

FORM A-423

			FLEXURE - 1000°F					
	SPECIMEN NO	APPLIED STRESS KSI	MAX DEFLECTION INCHES	TEMPERATURE °F	REMARKS			
	19	7.0	0.096	975	FRACTURED AT 975 - FAILED IN TENSION FIBERS			
	28	5.5	0.120	1000	NO FAILURE AT 1000°F			
	29	5.0	0.105	1000	NO FAILURE AT 1000°F			
	30	6.0	0.115	987	FRACTURED AT 987°F - FAILED IN TENSION FIBERS			
	37	6.0	0.170	1000	NO FAILURE AT 1000°F			
AVERAGE			0.121					
			FLEXURE - AMBIENT (78°F)					
	SPECIMEN NO	MAX FIBER STRESS KSI	MAX DEFLECTION INCHES	BEND MODULUS $E_B \times 10^6$	REMARKS			
	3	68.1	0.132	2.81				
	4	67.4	0.133	2.86				
	12	69.7	0.126	3.13				
	13	72.6	0.123	3.39	ALL FAILURES OCCURED IN TENSION FIBERS			
	20	62.5	0.114	2.88				
	21	62.5	0.115	2.91				
	31	55.3	0.116	2.57				
	32	65.3	0.125	2.81				
AVERAGE		65.4	0.123	2.92				
			FLEXURE - -320°F					
	SPECIMEN NO	MAX FIBER STRESS KSI	MAX DEFLECTION INCHES	BEND MODULUS $E_B \times 10^6$	REMARKS			
	5	86.3	0.156	3.08				
	6	71.9	0.131	3.44				
	14	99.5	0.164	3.41	ALL FAILURES OCCURED IN COMPRESSION FIBERS			
	15	101.4	0.172	3.33				
	22	89.6	0.150	3.36				

FIG 3 - ADLOCK 851 - FLEXURAL PROPERTIES OF

FORM A-423

			FLEXURE -320°F (CONT'D)					
	23	89.1	0.151	3.39				
	33	68.4	0.128	2.87	ALL FAILURES OCCURED IN COMPRESSION FIBERS			
	34	73.1	0.138	2.91				
AVERAGE		84.3	0.149	3.22				
			FLEXURE - -423°F					
	SPECIMEN NO	MAX FIBER STRESS KSI	MAX DEFLECTION INCHES	BEND MODULUS E x 10⁶	REMARKS			
	7	75.4	0.113	3.28				
	8	73.8	0.098	3.52				
	16	92.3	0.130	3.51				
	17	93.9	0.146	3.70	ALL FAILURES OCCURED IN COMPRESSION FIBERS.			
	24	87.8	0.112	3.99				
	25	89.8	0.133	3.39				
	35	66.1	0.094	3.44				
	36	68.9	0.111	3.10				
AVERAGE		81.0	0.117	3.49				

FIG 3 - ADLOCK 851 - FLEXURAL PROPERTIES OF

			TENSILE DATA- 1000°F					
		SPECIMEN NO	TEST °F TEMP	ULT STRENGTH KSI		REMARKS		
		1	1000	18·1		FAILED IN END FITTING		
		2	1000	9·2				
		9	1000	12·5				
		11	1000	9·0				
		12	1000	18·5				
AVE. ULTIMATE KSI	13·5		TENSILE DATA- AMBIENT (78°F)					
		SPECIMEN NO	TEST °F TEMP	ULT STRENGTH KSI		REMARKS		
		3	78	36·2				
		4	78	34·1		ALL SPECIMENS BROKE IN THE RADIUS		
		13	78	34·9				
		14	78	34·6				
AVE. ULTIMATE KSI	35·0		TENSILE DATA- -320°F					
		SPECIMEN NO	TEST °F TEMP	ULT STRENGTH		REMARKS		
		5	-320	44·1 *		FAILURE INITIATED BY KNIFE EDGES		
		6	-320	78·0		FAILED IN END FITTING		
		15	-320	76·8		FAILED IN RADIUS		
		16	-320	66·1		FAILED IN RADIUS		
AVE. ULTIMATE KSI	73·6		TENSILE DATA - -423°F					
		SPECIMEN NO	TEST °F TEMP	ULT STRENGTH KSI		REMARKS		
		7	-423	41·0 *		SHARP BREAK AT KNIFE EDGE		
		8	-423	63·3		DELAMINATED		
		17	-423	54·5		DELAMINATED		
AVE ULTIMATE KSI	63·6							
	* THESE VALUES WERE NOT INCLUDED IN THE AVERAGES.							

FIG 4- ADLOCK 851 - TENSILE PROPERTIES OF

FORM A-423

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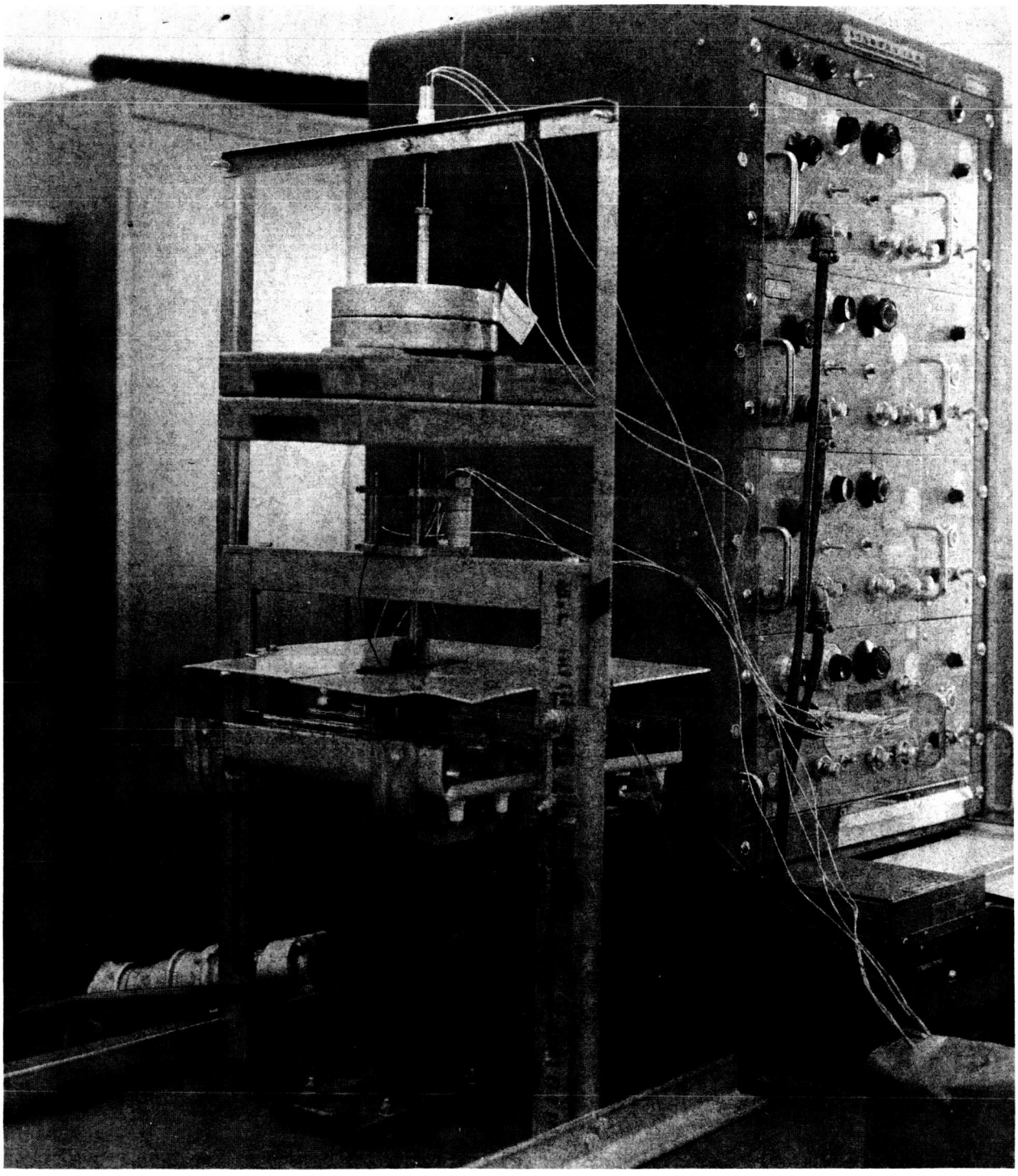
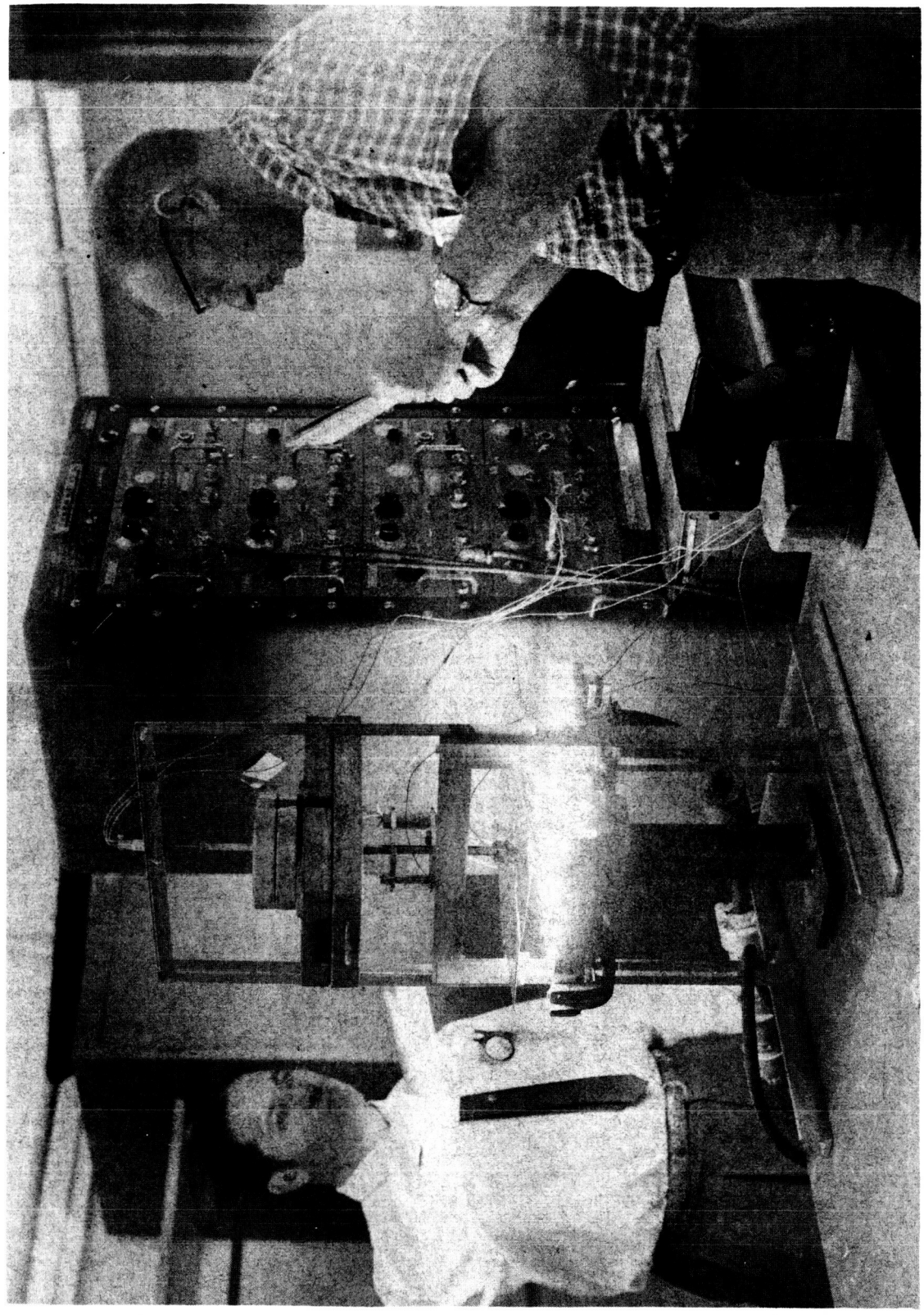
MODEL



FLEXURE TEST SET UP FOR USE AT 1000°F UNDER CONSTANT LOAD
FIGURE NO. 5



ACTUAL TEST RUN OF FLEXURE TEST AT 1000°F
FIGURE NO. 6